June 19, 2020

Mr. Brandon Roberts
Office of Rulemaking
Acting Designated Federal Official, Aviation Rulemaking Advisory Committee
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

RE: Flight Test Harmonization Working Group; Topic 31 Final Recommendation Report

Dear Mr. Roberts,

On June 18, 2020, the Aviation Rulemaking Advisory Committee (ARAC) voted unanimously to accept the Final Recommendation Report ("Report"), submitted by the Flight Test Harmonization Working Group (FTHWG) on Topic 31 –V_{Df}/M_{Df}. However, ARAC would like to clarify some of the language used in the Report regarding the role of the Federal Aviation Administration's (FAA) representative who participates in the FTHWG as a non-voting member.

Beginning on Page 10, references are made to an FAA dissenting opinion. ARAC members understand this section to mean, as clarified during the ARAC meeting, that any FAA position or guidance provided during the FTHWG's proceedings was technical in nature. It is important to note that FAA advice and guidance on ARAC Working Groups is not intended to reflect the FAA's formal position. At the same time, FAA's participation on our Working Groups is incredibly valuable.

As you know, the work of the FTHWG is complex and requires specialized expertise. ARAC would like to thank the team for this report and its understanding the unique intricacies of this issue and working tirelessly to enhance aviation safety.

On behalf of the ARAC members, please accept the FTHWG Final Recommendation Report and submit to the relevant program offices for consideration and implementation. Please do not hesitate to contact me with any questions. Thank you very much.

Sincerely yours,

Yvette A. Rose
ARAC Chair
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cc: Keith Morgan, TAE Chair
Brian Lee, Boeing, Working Group Co-Chair

FAA Aviation Rulemaking Advisory Committee

FTHWG Topic 31
V_{DF}/M_{DF} vs. V_D/M_D

Recommendation Report
April 2020

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Executive Summary

Subpart G paragraph 25.1505 states that the minimum speed margins required for structural design between cruise speeds V_C/M_C and design dive speeds V_D/M_D are also to be observed between maximum operating speeds V_{MO}/M_{MO} and flight test demonstrated dive speeds V_{DF}/M_{DF}. However, with flight controls systems operating normally, airplanes equipped with high airspeed or high Mach number protection functions might not be able to achieve the intended values of V_{DF}/M_{DF} during flight tests, due to the very nature of the non-overridable protection functions.

This inconsistency – combined with the lack of a precise definition for V_{DF}/M_{DF} and absence of clear guidance for envelope protected airplanes on this matter – has led OEM's and Airworthiness Authorities to adopt different interpretations and ultimately different practices when establishing V_{DF}/M_{DF} for flight test demonstrations of handling qualities, vibration or flutter.

During the work on these issues the Flight Test Harmonization Working Group was augmented with Loads and Structures experts from the member organizations (OEM's and Airworthiness Authorities). The group also reviewed in-service incidents where significant overspeed was observed. The FTHWG proposals detailed in this report include the following items:

- Harmonization of §25.335(b)(1) regulation and guidance for envelope protected airplanes, including addition of a dedicated upset maneuver (-15 deg flight path upset) derived from previous Special Conditions for high speed protected airplanes, and clarification that the means of compliance need not include dedicated flight test demonstrations. The proposal also includes a requirement for non-overridable envelope protection failure conditions.
- Update to AC 25.335-1A guidance, including clarification of the necessary conditions for credit of reduced structural design dive speeds for airplanes equipped with non-overridable envelope protection functions and clarifications on atmospheric variations and considerations for instrument errors and production variations when applicable.
- Update to §25.253(b) to establish that V_{FC}/M_{FC} need not exceed the maximum steady speed achievable with full forward control input for airplanes equipped with a non-overridable High Speed Protection Function, limited such that it is at least the speed at which effective speed warning occurs.
- Inclusion of new regulation §25.253(d) to precisely define V_{DF}/M_{DF}. This new definition clarifies that V_{DF}/M_{DF} are speeds selected by the applicant to be used during flight tests when showing compliance with the applicable regulations (below).
- Regulation and/or guidance for handling qualities paragraphs 25.251, 25.253 and 25.255 and flutter flight tests of §25.629(e) are amended to allow disabling or modifying envelope protection functions for flight test purposes, thus allowing increased speeds to be reached if so needed in showing compliance to specific aspects of each regulation. The same types of success criteria currently used for conventional airplanes were maintained for envelope protected airplanes, although quantitative criteria were modified to qualitative criteria in some cases, in line with the modified control laws that may be needed for those tests. Quantitative criteria for §25.255(f) were modified to address protected and unprotected airplanes.
- Regulation and guidance for paragraph 25.1505 is revised to add clarity on its intent and criteria and the relationship between the minimum speed margins to be used for structural design (V_C/M_C to V_D/M_D) and the minimum speed margins to be demonstrated in flight (V_{MO}/M_{MO} to V_{DF}/M_{DF}). Criteria for failure conditions were also included.

These proposals complement the FTHWG Phase 2 Topics 1, 7 and 13 proposals related to High Speed Protection Functions.

Background

Structural regulations of Subpart C define design dive speeds V_D/M_D as the greater of the speeds achieved during a standardized upset-dive from cruise speeds V_C/M_C (§25.335(b)(1)) or the speeds achieved following standardized atmospheric disturbances or wind gusts (§25.335(b)(2)).

Handling qualities related regulations of Subpart B (§25.251, §25.253, §25.255) and flutter flight tests required in Subpart D §25.629(e) refer to V_{DF}/M_{DF}, the demonstrated flight diving speed, for which no precise definition is presented. Although airplanes equipped with airspeed or Mach number envelope protection functions usually have their certification basis amended by Special Conditions or Equivalent Safety Findings (or the most recent amendments of EASA's CS 25), these documents provide no additional clarification regarding V_{DF}/M_{DF}.

Subpart G paragraph 25.1505 and its respective guidance in AC 25-7D make a link between V_D/M_D, V_{DF}/M_{DF} and their appropriate minimum margins to the limit operating speeds V_{MO}/M_{MO}.

Existing conventional (unprotected) airplanes and those equipped with High Speed Protection Functions (HSPF) typically have their V_D defined by the upset-dive maneuvers, while M_D is typically driven by the wind gusts of AC 25.335-1A. Since Subpart B handling qualities flight tests are intended to assess the airplane with all systems operating normally (except for one engine inoperative in some cases) and given that §25.335(b)(2) wind gust levels are rare and not present during the flight tests, the maximum speed achievable during flight tests of envelope protected airplanes in normal mode may be insufficient to satisfy the minimum margins originally intended by §25.1505.

This conflict between HSPF designs and §25.1505 was first noted during the FTHWG discussions of §25.255 on Topic 13 – Out of Trim (see FTHWG Phase 2 final report). From the start of Phase 3 Topic 31, the original Handling Qualities and Flight Test specialists within the FTHWG invited Loads & Dynamics and Structures specialists from the various member organizations to help cover the full scope of issues regarding V_{DF}/M_{DF} (Subpart B) and V_D/M_D (Subpart C).

After an initial sharing of current practices based on existing Special Conditions and Equivalent Safety Findings it was apparent that the existing certification bases were not sufficient to guarantee consistency amongst different projects.

Considerable time was then spent in reviewing the genesis and the rationale behind the aforementioned regulations and guidance, such as the reference to effects of "automatic systems" in the minimum margins to V_D/M_D in §25.335(b)(2), the severity of the wind gusts defined in AC 25.335-1A and different interpretations of §25.1505. The group also reviewed in-service incidents where significant overspeed was observed.

The FTHWG also spent significant time discussing the accounting of instrument errors and airframe production variations in determining the margin between V_C/M_C and V_D/M_D. Although the proposed guidance material to §25.335 has added references to §25.1323 as a means to address instrument errors, no guidance to production variation was developed. Part of the difficulty in addressing production variation is the absence of a Part 25 regulation addressing airframe to airframe differences. Proposals accounting for a 1 in 100 airplane drove additional discussion regarding how to show compliance when structural design speeds are set early in the design, prior to flight tests. In consideration of the timing of this report the subject reached a point where the FTHWG was appeased for now, but recommends revisiting the issue in the future.

The FTHWG also discussed the need for minimizing flight test risk and exposure to limit case overspeed conditions during the course of a flight test program, as well as the benefits of High Speed Protection Functions (HSPF), while balancing the need for a robust flight test evaluation.

A. What is the underlying safety issue addressed by the FAA CFR / EASA CS?

Airplane structural design shall consider speed excursions beyond maximum approved operating speeds (V_{MO}/M_{MO}), including the speed excursions resulting from atmospheric disturbances. The airplane should be free from flutter or excessive vibration. Also, handling characteristics in the overspeed range should be adequate to allow the airplane to safely and promptly return to the normal speed envelope.

B. What is the task ?

To recommend harmonized means of assessing high speed characteristics for high speed protected airplanes.

To recommend harmonized means of establishing structural design dive speeds for high speed protected airplanes.

To develop sufficient guidance to clarify the several regulations referring to either V_D/M_D or V_{DF}/M_{DF}.

C. Why is this task needed ?

Existing regulations and guidance did not envision high speed protected airplanes. Regulation §25.1505 in particular requires the minimum margin between V_{MO}/M_{MO} and V_{DF}/M_{DF} to be at least the minimum margin established between V_C/M_C and V_D/M_D. Since V_D/M_D may be driven by a severe atmospheric disturbance specified in §25.335(b)(2), it renders impracticable for some high speed protected airplanes to achieve the intended V_{DF}/M_{DF} during flight tests with flight controls in the normal mode.

In addition, there is not a comprehensive definition of V_{DF}/M_{DF} in the current regulations and OEM's and Airworthiness Authorities dealing with this subject have been inconsistent in the interpretation and application of the regulations regarding flight tests in overspeed conditions.

D. Who has worked the task ?

The Flight Test Harmonization Working Group, during Phase 3 activities, has worked the task. The group was augmented with Loads and Structures specialists. Participants in this FTHWG task included:

Airframe Manufacturers:
Airbus, Boeing, Bombardier, Dassault, Embraer, Gulfstream and Textron

Airworthiness Authorities:
FAA, EASA, TCCA and ANAC (CAAI and JCAB as observers)

Operators:
Norwegian (as an observer)

Labor Union:
ALPA

E. Any relation with other topics?

FTHWG Phase 2 Topic 1 – Envelope Protection – discusses the basic criteria for certification of airplanes with envelope protection functions under the proposed §25.144, including the definition of a High Speed Protection Function (HSPF) and minimum reliability criteria for such functions. Implementation of those proposals from Phase 2 Topic 1 related to HSPF is a pre-requisite for the implementation of the proposals contained in this report.

FTHWG Phase 2 Topic 7 – Side Stick Controls – introduces criteria for side stick control forces. This Topic 31 report includes modifications to some of the guidance previously addressed in Topic 7. Implementation of those proposals from Phase 2 should be coordinated with the proposals contained in this report.

FTHWG Phase 2 Topic 13 – Out of Trim Characteristics – discusses flight test demonstrations at V_{DF}/M_{DF}. This Topic 31 report includes modifications to previous proposals from Topic 13. Implementation of those proposals from Phase 2 Topic 13 related to Out-of-trim characteristics should be coordinated with the proposals contained in this report.

Historical Information

A. What are the current regulatory and guidance material in CS-25 and FAR 25?

Handling qualities regulations and guidance:

- Paragraph 25.251 – Vibration and Buffeting
- Paragraph 25.253 – High Speed Characteristics
- Paragraph 25.255 – Out of Trim Characteristics
- AC 25-7D
- CS 25 Book 2

Loads and structures regulations and guidance material:

- Paragraph 25.629(e) – Flight Flutter Testing
- Paragraph 25.335(b) – Design Dive Speed V_D/M_D
- Special Conditions and CS 25.335(b) – Additional V_D/M_D criteria for protected airplanes
- AC 25.335-1A – Design Dive Speed - Gusts
- AC 25.629-1B – Aeroelastic Stability Substantiation of Transport Category Airplanes - Flutter Flight Testing
- AMC 25.335(b)(1)(ii)- Design Dive Speed – High speed protection function
- AMC 25.335(b)(2) – Design Dive Speed (Gusts)
- AMC 25.629 – Aeroelastic stability requirements

Operating Limitations regulations and guidance:

- Paragraph 25.1505 – Maximum Operating Limit Speed
- AC 25-7D section 10.2 – High Speed Characteristics

B. What, if any, are the differences in the existing regulatory and guidance material CS 25 and FAR 25?

CS 25, starting with Amendment 13, includes criteria for high speed protected airplanes in §25.335(b)(1). These criteria are based on previous Special Conditions and are not currently in FAR 25.

Although based on previous Special Conditions, the text included in CS 25 is unclear about the use of analysis rather than flight test demonstrations for the -15 deg flight path upset maneuver.

Although regulation §25.1505 is similar in FAR 25 and CS 25, the guidance is substantially different. The FAA AC 25-7D includes a discussion about the applicability of the “same margin” between V_{MO}/M_{MO} and V_{DF}/M_{DF} as that determined under §25.335(b) between V_C/M_C and V_D/M_D. EASA’s CS25 book 2 (or AMC) does not include this discussion.

EASA’s CS 25 §25.302 and Appendix K “Interaction of Systems and Structure” discuss systems (such as a HSPF) affecting the structural performance of the aircraft, either directly or as a result of a failure or malfunction. This regulation is not yet harmonized with the other authorities. The direct effects of a HSPF (i.e. the effects of the normal operation of the system) on the speed margins between V_C/M_C and V_D/M_D and between V_{MO}/M_{MO} and V_{DF}/M_{DF} are addressed in the proposals contained in this report. Similarly, the margins between the operating speed limits of a HSPF failed/inoperative and V_{DF}/M_{DF} are addressed in this report. However, other aspects of CS 25 §25.302 and Appendix K (e.g. the effect of the onset of a HSPF failure on the structural performance) were considered out of scope of Topic 31 and were not addressed by the FTHWG. These additional considerations should be subject for future harmonization and the proposals contained in this report should be complemented accordingly at a later stage.

C. What are the existing CRIs/IPs (SC and MoC)?

The existing SC’s for high speed protected airplanes impose an additional -15 deg flight path upset-dive maneuver in the determination of V_D/M_D. Most of these SC’s specify that the upset maneuvers can be shown by analysis if reliable or conservative data is used.

For one applicant the SC is unclear about the use of analysis rather than flight test demonstrations of the -15 deg flight path upset maneuver.

TCCA has an ELOS with similar content to the SC’s.

D. What, if any, are the differences in the Special Conditions (CRIs/IPs) (SC and MoC) and what do these differences result in?

For one applicant the §25.335(b)(1) Issue Paper specifies “simulation” as the MoC for the -15 deg flight path upset maneuver. As discussed in section B above, CS 25 amendment 13 is unclear about this MoC.

Consensus

The group shared current practices for each of the applicable regulations. Different proposals were made attempting to address the issue of handling qualities flight test demonstrations at V_{DF}/M_{DF} for high speed protected airplanes where the speed may not be achievable. An initial majority position was formed around a draft proposal, which consisted of performing all the high speed handling tests up to the maximum speed achievable in normal mode and, in addition, a qualitative assessment up to speeds inclusive of §25.335(b)(2) with the envelope protections modified or disabled; possibly a direct mode dive combining handling qualities assessment with flutter flight tests. At this point the group had already concluded that flutter flight tests should be carried out to speeds inclusive of §25.335(b)(2) gusts, even though modified flight controls might be required to achieve these speeds.

The OEM's provided the following list of arguments to support the notion that a limited qualitative assessment of handling qualities beyond the protected envelope would be sufficient to demonstrate safety for high speed protected airplanes:

i. It is important to minimize flight test risk by containing the amount of speed excursions (maximum speed near M_D) and the exposure time (number of tests) to a minimum.
ii. Any speed increment between the maximum speeds obtained from §25.335(b)(1) flight path upsets and §25.335(b)(2) gusts represents a transient condition because of the transient nature of the wind gust profile specified in AC 25.335-1A.
iii. Existing high speed protection control laws start acting instantly and automatically upon reaching an overspeed condition so as to bring the aircraft back to the protected envelope. As the group shared a few examples it became clear that the predicted exposure time beyond §25.335(b)(1) caused by the gusts of §25.335(b)(2) is of the order of a few seconds.
iv. According to the data shared within the group regarding overspeed events observed in service it became apparent that gust levels of magnitude similar to the ones specified in AC 25.335-1A are very rare.
v. If any type of dedicated flight test control law is required for high speed handling assessment (other than the design's available modes (e.g. direct mode or alternate mode) it would mean adding extra complexity and costs to the overall development of FBW systems, potentially with added flight test risks also, due to the lower maturity of the modified version of the control laws.
vi. Handling qualities flight tests with modified control laws are not representative of the type design regarding specific aspects of the regulations.
vii. If adding a high Mach protection to the design adds complexity, time, costs and potentially even number of tests, with no apparent benefit to the OEM in return (in the Mach regime), OEM's might be tempted to design high speed protections that do not cover the Mach regime (with or without gusts). That was in fact the case on a recent US program. Although that airplane was demonstrated to be safe according to the current regulations for conventional airplanes, existing FAA policy on high speed testing apparently precluded an even safer design (beyond current Part 25 standards). This is contrary to one of the FTHWG declared objectives: to streamline FBW related regulations to help promote the adoption of envelope protections in future designs.

In addition, the OEM's provided the following list of arguments to support the notion that additional considerations for instrument errors and production variations need not be included in the §25.335(b)(1) and (b)(2) analyses, provided the atmospheric variation levels specified in AC 25.335-1A are used and the effects of air data instrument errors on automatic systems are considered in the analyses:

i. §25.335(b)(1) upsets constitute standards for structural design. The specified maneuvers are not correlated to operational scenarios nor are they representative of expected pilots' reactions to overspeed excursions. Since the specified upsets are conservative, no additional consideration for instrument errors and production variations should be required.
ii. Atmospheric variations, instrument errors and production variations are mentioned in §25.335(b)(2) but not on §25.335(b)(1). Nowhere in the current structural regulations or guidance is an indication that those factors need to be considered in combination with the upsets of (b)(1). Even if "The minimum speed margin" referenced at the beginning of (b)(2) was supposed to be interpreted as "The margin from (b)(1) above", there is no possible interpretation of that regulation that would lead an applicant to apply instrument errors and production variations on top of the (b)(1) upset analyses but exclude the atmospheric variations from those same analyses. In other words, it would be incoherent to assume that a very specific part of (b)(2) is applicable to (b)(1) but not all of it. Therefore, it is reasonable to interpret (b)(2) as a standalone regulation, with no interlink with (b)(1) except for the fact that V_D/M_D are the higher values obtained from the two types of analyses. Instrument errors and production variations assessment have not been mandated by regulation for (b)(1).
iii. Past and current practice of the majority of the applicants is to disregard instrument errors and production variations from §25.335(b)(1) analyses. Nevertheless, the sum of all Part 25 in-service fleet history to date shows no evidence of lack of structural integrity, even in cases where large speed excursions were reported. The OEM's practices have resulted in safe airplanes in terms of structural design.
iv. The gust levels specified in AC 25.335-1A are extreme and therefore rare. The list of speed excursion events shared in this group during FTHWG-42 (Wichita, June 2017) is evidence that these levels of atmospheric variations are rare. Therefore, speed margins calculated with these gust levels should be sufficiently conservative, without any additional consideration for instrument errors or production variations. In addition, structural design regulations are conservative in nature (e.g. 50% safety margin between limit loads and ultimate loads, or 15% margin between V_D/M_D and flutter onset).
v. Past and current practice of the majority of the applicants is to use the default margin of 0.07 Mach for §25.335(b)(2) analyses without any additional consideration for instrument errors or production variations. The few OEM's currently using lower margins (typically >0.06 Mach) have also successfully negotiated with the Airworthiness Authorities to disregard any additional consideration for instrument errors and production variations, provided they use the default gusts levels from AC 335-1A. Nevertheless, the sum of all Part 25 in-service fleet history to date shows no evidence of lack of structural integrity, even in cases where large speed excursions (some caused by gusts) were reported. The OEM's practices have resulted in safe airplanes in terms of structural design.

The FAA dissented on the initial draft proposal for Handling Qualities assessment. Following are the three core rationales the FAA offered the group in return:

i. Notwithstanding the fact that severe wind gusts of the same order of magnitude as the ones in AC 25.335-1A are rare and the nature of such phenomena is transient, they may eventually occur in service. Therefore, it is preferable to incur added flight test risk than a potential unforeseen operational risk, particularly when flight tests can be conducted in a controlled environment where risk is manageable.
ii. As presented in the draft form, it is unclear to the FAA how the majority proposal covers each relevant aspect of the existing high speed handling qualities regulations. It needs to be detailed.
iii. It is the FAA position that flight tests should be conducted to demonstrate compliance with all current aspects of the Subpart B handling qualities regulations, up to V_{DF}/M_{DF} values consistent with the structural regulations of Subpart C, including the speeds achieved with §25.335(b)(2) gusts.

The Structures Airworthiness Authorities dissented on the initial proposal to disregard instrument errors and production variation from §25.335(b) analyses. The core concern from these authorities was that accountability for instrument error and production variation could be an important component when demonstrating that the speed margins resulting from the analyses are "shown to be reliable or conservative", per §25.335(b) language.

In response, the FTHWG worked towards detailing the proposals individually for each applicable Subpart B regulation and their respective guidance material, guaranteeing that each relevant flight characteristic specified in the existing regulations are adequately addressed for high speed protected airplanes.

Subpart C guidance was also modified to introduce criteria for instrument error accountability. Differences and similarities exist between the terminology used for air data errors and the values of those errors, as specified in the proposed changes to the guidance in AC 25-7 and AC 25.335 and shown in the table below. AC 25-7 has historically included values for the different errors, but these have not been included in AC 25.335 or other guidance. These differences are considered minor.

Type of Error	**§25.253 (proposed changes to AC 25-7)**	**§25.335 (proposed changes to AC 25.335)**
"Increment for production tolerances in airspeed systems"	3 knots/.005M unless larger tolerances are found to exist. Smaller tolerances may be accepted if adequately substantiated.	
"Airspeed indicating system installation error (ref. §25.1323(c))" *This is commonly known as residual positioning error*		If the error is shown to be less than 3 KEAS, it does not need to be considered. If the error is shown to be greater than 3 KEAS, the entire error should be considered in determining the margin due to upset maneuvers and atmospheric variations.
Overspeed warning system tolerances	Should be included. The overspeed warning margin above V_{MO}/M_{MO} plus system tolerances should be 6 knots/.01M.	"Where compliance with §25.335(b)(1) or (b)(2) is dependent upon activation of an overspeed warning, the system tolerances should be considered." Applies to upset maneuvers and atmospheric variations. No specific numbers provided.

Digital interface The guidance is worded differently but has the same meaning.	"For an airplane with digital interface between the airspeed system and the overspeed warning system, <u>the overspeed warning system tolerance may be deleted when adequately substantiated, leaving only the nominal margin between V_{MO}/M_{MO} and the overspeed warning activation to be included</u>."	"For an airplane with digital interface between the airspeed system and the overspeed warning system, <u>the production tolerance for the overspeed warning system may be deleted when adequately substantiated, therefore only the nominal setting of the overspeed warning activation should be considered</u>."
Analytical considerations when aircraft response is dependent on air data input to any automatic system.	Not addressed because flight test accounts for these inputs.	"If the aircraft response is dependent on air data input to any automatic system (e.g. HSPF gain schedules, Nz command, control law gains, feedback or feedforward factors, etc. are a function of the input air data in the overspeed range) then the applicant should consider the effects of air data errors (i.e. errors in the air data input for the HSPF) in the overspeed range in order to ensure that the resulting analytically calculated speed margins from §25.335(b)(1) and (b)(2) are reliable or conservative."

The final form of the FTHWG proposal as detailed in Attachments 31B through 31H achieved full consensus on the technical aspects with one comment and one dissent on an administrative aspect. The proposals include:

- Modifications to §25.251 guidance, §25.253 regulation and guidance, and §25.255 regulation and guidance. The proposed changes address the vibration and buffeting and the handling qualities aspects of the high speed tests and provide a clear definition for V_{FC}/M_{FC} in §25.253(b) for HSPF equipped airplane and V_{DF}/M_{DF} under the new proposed regulation §25.253(d).
- Modification to §25.629(e) guidance, addressing flutter flight tests for high speed protected aircraft.
- Modifications to §25.335(b) regulation and guidance. The proposed changes harmonize the dive criteria and general guidance for structural design of high speed protected airplanes and clarify aspects of atmospheric variation analyses, instrument errors and production variations.
- Modifications to §25.1505 regulation and guidance, adding clarity to the intended relationship between the structural design margins (V_C/M_C to V_D/M_D) and the flight test demonstrated margins (V_{MO}/M_{MO} to V_{DF}/M_{DF}). Criteria for failure conditions were also included.

The following tables contain the aforementioned Comment and Administrative Dissent, along with the group's disposition:

Comment (not dissent)	FTHWG Disposition
ANAC: This report requires some tests to be done to the limit of the normal envelope protection. The proposed guidance defines such value in a standard maneuver looking for a compromise between exploring the envelope without requiring extreme maneuvers for each test point. However, ANAC is concerned with an OEM ignoring such compromise and read the proposed guidance to test in speeds significantly lower than currently tested when compared to the speed obtained during the §25.253(a)(1) upsets. ANAC considers that an OEM should demonstrate no force inversion up to the load factors described in §25.255(c) at speeds reached on §25.253(a)(1) upsets. Lower load factors than that from §25.255(c) would also be accepted if limited by the flight control law. ANAC considers that this specific concern is not addressed by the proposed tests in V_{DF}/M_{DF}. As usual practice in certification, ANAC would be willing to discuss flight test tolerances and credit from other maneuvers. These practices, however, should be discussed case-by-case during a particular certification campaign. ANAC believes that this concern would not require any additional OEM burden unless OEM willing to change their design to take specific credit that was not envisioned in this discussion. As an evidence, ANAC reinforces that, in its knowledge of past envelope-protected designs, the method proposed in this report would generally result in tests above the speeds reached in §25.253(a)(1) or at least in very similar speeds.	The group acknowledges the concern and offers that, a control law design capable of holding the gradual acceleration overspeed too short of the speeds achieved in §253(a) is also likely to produce load factors in excess of 1.5g at the upset recovery, even with the pitch controls in neutral position, therefore approaching the load factors specified in §25.255(c)(2). Otherwise, the maximum overspeed achieved following a gradual acceleration to full forward stick is likely to be close to the maximum speed achieved in the §253(a) upsets. Furthermore, the group does not envision a reason why an OEM would propose a control law significantly different than the descriptions above, unless the load factor envelope is being limited by other constrains already allowed by §25.255(e), such as aerodynamic buffet. The proposed guidance material for the §25.255(b) "achievable speed (under normal flight control system operation)" in Section 10.3.1 of Attachment 31H is consistent with the accepted means of compliance for §25.255(b) where a quantitative stick force vs Nz is to be determined. This can only be accomplished at a reasonably steady airspeed achievable with full forward stick input (for a HSPF equipped airplane). Qualitatively evaluating longitudinal stick forces per g during dynamic high speed upset and recovery should be partially accomplished (i.e. to the normal acceleration – Nz – level reached) as part of §25.253(a) compliance as noted in the proposed 10.2.1.7.1 of Attachment 31H where "Adequate handling qualities (e.g. adequate roll rate, normal load factor capability, control force gradients and absence of control reversal) should be observed during recovery demonstrations from the upset maneuvers of §25.253(a)(1)".

Administrative Dissent	FTHWG Disposition
FAA: The proposed change to regulation §25.253(a)(4) could be specified in guidance instead, to reduce the administrative burden of additional regulatory changes.	The proposed additional language in §25.253(a)(4) is consistent with similar existing language in §25.253(a)(5). The majority of the FTHWG voting members believe the new language in §25.253(a)(4) would be helpful in the sense that it adds clarity to the intended range of speeds to be flight tested. Moreover, the group considers these changes to be minor when compared to the complete set of changes to other regulations and guidance material contained in this report.

Recommendation

The Flight Test Harmonization Working Group – augmented with a group of Loads and Structures specialists from its voting member organizations – recommends the FAA to implement the following changes:

- Harmonization of §25.335(b)(1) regulation and guidance for envelope protected airplanes. It should include a dedicated upset maneuver (-15 deg flight path upset) derived from previous Special Conditions for high speed protected airplanes. It should clarify that the means of compliance need not include dedicated flight test demonstrations. It should include a requirement for failure conditions.
- Update to AC 25.335-1A guidance. It should clarify the necessary conditions for credit of reduced structural design dive speeds for airplanes equipped with automatic protection functions, and clarify the necessary considerations for atmospheric variations, instrument errors and production variations when applicable.
- Update to §25.253(b) to establish that V_{FC}/M_{FC} need not exceed the maximum steady speed achievable with full forward control input for airplanes equipped with a High Speed Protection function, limited such that it is at least the speed at which effective speed warning occurs.
- Inclusion of new regulation §25.253(d) to precisely define V_{DF}/M_{DF}. This new definition should clarify that V_{DF}/M_{DF} are speeds selected by the applicant to be used during flight tests when showing compliance with the applicable regulations (below).
- Regulation and/or guidance for handling qualities paragraphs 25.251, 25.253 and 25.255 and flutter flight tests of §25.629(e) should be amended to allow disabling or modifying envelope protection functions for flight test purposes, thus allowing increased speeds to be reached if so needed in showing compliance to specific aspects of each regulation. The same types of pass criteria currently used for conventional airplanes should be maintained for envelope protected airplanes, although quantitative criteria should be modified to qualitative criteria in some cases, in line with the modified/degraded control laws that may be needed to accomplish those tests. Quantitative criteria for §25.255(f) should be modified to address protected and unprotected airplanes.
- Regulation and guidance for paragraph 25.1505 should be rewritten to add clarity on its intent and criteria and the relationship between the minimum speed margins to be used for structural design (V_C/M_C to V_D/M_D) and the minimum speed margins to be demonstrated in flight (V_{MO}/M_{MO} to V_{DF}/M_{DF}). Criteria for failure conditions should also be included.

Attachments 31B through 31H contain the FTHWG detailed proposals. These proposals complement the FTHWG Phase 2 Topics 1 and 13 proposals related to High Speed Protection Functions.

In addition, the FTHWG recommends that EASA, TCCA, ANAC, and other national authorities adopt or encourage the adoption of the proposed harmonized regulatory and guidance material.

A. Rulemaking

1. What is the proposed action?

It is recommended that the FAA revise the regulation and guidance related to vibration and buffeting, high speed characteristics, out of trim characteristics, flutter flight testing, design dive speeds and maximum operating limiting speeds to address airplanes with high speed protection functions. The changes should focus on clarifying the relevant characteristics to be demonstrated up to speeds inclusive of §25.335(b)(1) and (b)(2) gusts, and the ones that require demonstrations in normal mode up to the protected envelope. In the former case, allowance should be specified in the regulations or guidance material for disabling or modifying the envelope protections as needed for flight tests. In addition, §25.335(b)(1) should be revised to introduce the -15 deg flight path upset maneuver for protected airplanes, similar to EASA's CS 25 Amdt 13, and introduce other clarifications.

Rulemaking and guidance change should be coordinated with other Subpart B changes proposed during the Phase 2 Topics 1, 7 and 13 activities of the FTHWG, since some of those proposals already establish new standards for High Speed Protection Functions.

2. What should the harmonized standard be?

Please refer to Attachment 31B: Proposed changes to 25.335(b) Regulation, Attachment 31E: Proposed changes to 25.1505 Regulation and Attachment 31G: Proposed changes to Subpart B Regulations.

3. How does this proposed standard address the underlying safety issue?

The proposed change to the §25.335(b)(1) recognizes that high speed protected airplanes necessitate an additional criterion when defining the design dive speeds (-15 deg upset-dive in normal mode). This criterion has already been applied via SC's or ESF's over the years for all protected airplanes.

The proposed changes to Subpart B standards address the fact that, even if equipped with a HSPF, an aircraft in service may encounter gusts such that airspeed or Mach number could be transiently higher than what can be achieved during dedicated flight tests maneuvers in normal mode. The proposal therefore specifies criteria to ensure that recovery from these high airspeed or Mach conditions is not impaired.

4. Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The proposed changes to §25.335(b)(1) and (b)(2) maintain the same level of safety. They keep the current standards for conventional airplanes and they introduce new criteria for high speed protected airplanes. The new criteria are already being applied to all high speed protected airplanes via SC's or ESF's.

The proposed changes to Subpart B standards will assure that the handling characteristics of high speed protected airplanes are always systematically evaluated up to speeds inclusive of §25.335(b)(1) and (b)(2). Although these levels of overspeed excursions are expected to be rare for protected airplanes, there is the possibility they might eventually occur. Therefore, the new standards may increase the level of safety.

The 1.2g criterion introduced in §25.255(f) already existed in the EASA guidance in a similar fashion. These changes are expected to maintain that same level of safety for protected airplanes. The proposed changes to §25.253(b) also maintain the same level of safety. The regulation remains unchanged for conventional airplanes and modifications were made to introduce clear criteria to define V_{FC}/M_{FC} for protected airplanes.

The proposed changes to §25.1505, in combination with the Subpart B proposed changes – in particular the introduction of §25.253(d) – are believed to streamline certification for high speed protected aircraft, thus possibly encouraging other OEM's to adopt envelope protection functions.

5. Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The proposed changes to the §25.335(b)(1) maintain the same level of safety since they have already been applied to high speed protected airplanes via SC's or ESF's. The proposed changes harmonize small differences in these Special Conditions and clarify points of discussion in previous programs. Some OEM`s currently perform flight tests for 25.335(b)(1) but previous SC`s did not require that.

The proposed changes to §25.335(b)(2) maintain the same level of safety since OEM's consistently use the gust levels specified in AC 25.335-1A to show compliance to this regulation by analysis.

Some OEM's currently perform the formal handling qualities assessments up to the maximum speed achieved from (1) the §25.253(a)(1) upset maneuvers plus the tolerances described in AC 25-7D and (2) a flight demonstration of the §25.335(b)(1) upsets. The new proposed speed for quantitative assessments in Normal Mode (maximum speed achieved following a gradual wings-level acceleration to full forward pitch control input) is potentially lower than the speeds resulting from §25.253(a)(1) or §25.335(b)(1), although it is not the intent of the FTHWG to promote envelope protection designs that would deliberately achieve this effect. Additionally, the proposal includes formal qualitative demonstrations at higher speeds (inclusive of §25.335(b)(1) and (b)(2)), encompassing all relevant flight characteristics specified in the existing regulations. Therefore, these proposals maintain the level of safety (see ANAC comment).

The proposed changes to Subpart B standards do not affect unprotected airplanes. The 1.2g criterion introduced in §25.255(f) already existed in the EASA guidance in a similar fashion. These changes are also expected to maintain that same level of safety for protected airplanes. Although a systematic evaluation of the handling characteristics is now being proposed with disabled or modified protection to allow reaching speeds inclusive of §25.335(b)(1) and (b)(2), the majority of the OEM's with high speed protected airplanes were already indirectly assessing minimum handling qualities and overspeed recovery capabilities when performing flutter flight tests close to V_D/M_D.

6. Who would be affected by the proposed change?

The OEM's and Airworthiness Authorities would be affected.

7. Does the proposed standard affect other HWG's and what is the result of any consultation with other HWGs?

The proposed standard and guidance changes affect the loads and structures community. Since there is currently no active HWG on these disciplines the FTHWG was augmented during the activities on this topic with loads and dynamics and structures SME's from several OEM's and also from the FAA, EASA and TCCA.

This group of SME's helped the FTHWG in understanding the background of §25.629(e), §25.335(b), §25.1505, their respective guidance, OEM's practices and local Airworthiness Authorities practices. They also actively participated in the elaboration of the proposed revised regulation and guidance included in Attachments 31B thru 31F.

B. Advisory Material

1. Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

It is not adequate. The FAA existing advisory material does not address high speed protected airplanes. Over the years, different interpretations of §25.1505 for this type of aircraft has led to different flight test practices and certification criteria.

Detailed proposals for guidance material can be found in Attachment 31C: Proposed changes to 25.335(b) Guidance, Attachment 31D: Proposed changes to 25.629(e) Guidance, Attachment 31F: Proposed changes to 25.253 and 25.1505 Guidance and Attachment 31H: Proposed changes to Subpart B Guidance.

2. To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble?

For harmonization purposes, it is recommended that ANAC, EASA and TCCA regulation and guidance material be revised to reflect that proposed for the FAA regulations and advisory material. With these changes, nothing more need be included.

Economics

A. What is the cost impact of complying with the proposed standard (it may be necessary to get FAA Economist support to answer this one)?

Different OEM's are currently applying different means of compliance to the applicable high speed regulations. After the implementation of the proposed standard and guidance material the cost impact could be positive, neutral or negative depending on the current practice.

For example the proposed change to §25.335(b)(1) and its respective guidance potentially reduces the cost for OEM's that traditionally have been demonstrating the -15 deg upset maneuver by flight tests. There is no impact for OEM's that use simulation/analysis and a slight cost reduction for OEM's that use pilot-in-the-loop simulation.

Similarly, introduction of Subpart B maneuvers to speeds inclusive of §25.335(b)(1) and (b)(2) would mean no impact for OEM's already planning the flight tests accordingly. But there could be some cost increase to OEM's that currently restrict the flight testing to the maximum speeds achievable in normal mode. The FTHWG has evaluated that this extra cost could be partially diluted if the new handling qualities demonstrations to the higher speeds are planned and executed in the existing Direct Mode or Alternate Mode and, whenever allowed by local regulation regarding Type Inspection Authorization, in coordination with the flutter flight tests.

The proposed changes to §25.255(f) relative to the Phase 2 Topic 13 proposals are expected to produce no cost impact, since the regulation already includes recovery capability testing at V_{DF}/M_{DF} with guidance material stating that envelope protections may be disabled or modified as needed to achieve V_{DF}/M_{DF} and the 1.2g criterion was already included in the EASA guidance material.

B. Does the HWG want to review the draft NPRM prior to publication in the Federal Register?

Yes, please. The FTHWG would like to review NPRM's and NPA's on this subject.

ICAO Standards

How does the proposed standard compare to the current ICAO standard?

The sections below from ICAO annex 8 Part IIIB are related to this discussion:

> "Section 3.5.1 – Design airspeeds shall be established for which the aeroplane structure is designed to withstand the corresponding maneuvering and gust loads. To avoid inadvertent exceedances due to upsets or atmospheric variations, the design airspeeds shall provide sufficient margin for the establishment of practical operational limiting airspeeds. In addition, the design airspeeds shall be sufficiently greater than the stalling speed of the aeroplane to safeguard against loss of control in turbulent air. Consideration shall be given to a design maneuvering speed, a design cruising speed, a design dive speed, and any other design airspeeds necessary for configurations with high lift or other special devices."
>
> "Section 3.5.2 – Limiting airspeeds, based on the corresponding design airspeeds with safety margins, where appropriate, in accordance with 1.2.1, shall be included in the flight manual as part of the operating limitations (see 7.2)."
>
> "Section 7.2.3 – The airspeed limitations shall include all speeds (see 3.5) that are limiting from the standpoint of structural integrity or flying qualities of the aeroplane, or from other considerations. These speeds shall be identified with respect to the appropriate aeroplane configurations and other pertinent factors."

The proposals included in this FTHWG report are not in conflict with the ICAO standards above.

Attachment 31A: Topic 31 Work Plan

1. What is the task?
To recommend a harmonized means of defining V_{DF}/M_{DF} and assessing high speed characteristics for high speed protected airplanes.
2. Who will work the task?
The Flight Test Harmonization Working Group (FTHWG) will have primary responsibility for this task. The group may be complemented by Loads and Structures SME's from the various participant organizations. Occasional consultation with the Structures Harmonization Working Group may also be required.
3. Why is this task needed? (Background information)
During the Phase 2 discussions of Topics 1 and 13 (Envelope Protections and Out of Trim) the FTHWG realized there is currently no clear, harmonized definition of V_{DF}/M_{DF} (Subpart B) as opposed to V_D/M_D (Subpart C) for airplanes equipped with High Speed Protection Functions (HSPF). These discussions were triggered by a passage of AC 25-7C section 32a.(6) which presents an interpretation §25.1505 (Subpart G) linking the §25.253 demonstrations to the §25.335(b) demonstrations in terms of margins to V_{MO}/M_{MO}. Although §25.335(b)(2) recognizes the potential use of automatic systems to restrict overspeed excursions, current guidance to §25.251, §25.253 and §25.255 is not clear about the max speed to be demonstrated during handling qualities assessment for high speed protected aircraft. As a result, some applicants have defined V_{DF}/M_{DF} as the maximum speed achieved during the §25.253 demonstrations with the HSPF operating, complemented by flutter flight test up to V_D/M_D. Others have disabled or modified their HSPF during the handling tests to allow achieving higher speeds, closer to V_D/M_D, despite this modified configuration not being necessarily representative of the production airplane. A third group of applicants have been required to complement their HSPF ON demonstrations with some specific HSPF OFF demos. This lack of harmonization for protected airplanes has led also to precautionary dissenting opinions being raised by some organizations during the writing of FTHWG Phase 2 reports, in the sessions dealing with §25.253 and §25.255 recommendations for demonstrations at V_{DF}/M_{DF}. Therefore, even though this topic was not envisioned during Phase 1 prioritization, the FTHWG decided it should get a high priority within Phase 3 schedule.
4. References (existing regulatory and guidance material, including special conditions, CRIs, etc.)
14 CFR Part 25 regulations §25.251, §25.253, §25.255, §25.335, §25.629, §25.1505 AC 25-7C section 32 FTHWG Phase 2 final report, 2017, Appendix 1 and Appendix 9 CS 25.335(b) Amendment 13 (for protected aircraft) TCCA Working Note No. 27 TCCA Memo 40292 FAA Memo 120292
5. Working method
It is envisioned that 5-6 one day face-to-face meetings will be needed to facilitate the discussion needed to complete this task. Telecons and electronic correspondence will be used to the maximum extent possible.
6. Preliminary schedule (How long?)
Recommendations to Transport Airplanes and Engines Subcommittee within 18 months of the initiation of work on these tasks.

7. Regulations/guidance affected
14 CFR Part 25 regulations §25.251, §25.253, §25.255, §25.335, §25.629, §25.1505 AC 25-7C section 32

8. Additional information

Relevant extracts from the current FAA regulation and guidance:

"§25.251(b) Each part of the airplane must be demonstrated in flight to be free from excessive vibration under any appropriate speed and power conditions up to $\mathbf{V_{DF}/M_{DF}}$. The maximum speeds shown must be used in establishing the operating limitations of the airplane in accordance with Sec. **25.1505**.

"§25.253(a)(3) With the airplane trimmed at any speed up to V_{MO}/M_{MO}, there must be no reversal of the response to control input about any axis at any speed **up to** $\mathbf{V_{DF}/M_{DF}}$. (…)"

"§25.255(f) In the out-of-trim condition specified in paragraph (a) of this section, it must be possible from an overspeed condition **at** $\mathbf{V_{DF}/M_{DF}}$ to produce (…)"

"§25.335 (b) Design dive speed, $\mathbf{V_D/M_D}$ must be selected so that V_C/M_C is not greater than (…)
(2) The minimum speed margin must be enough to provide for atmospheric variations (such as
horizontal gusts, and penetration of jet streams and cold fronts) and for instrument errors and airframe production variations. These factors may be considered on a **probability basis**. The margin at altitude where Mc is limited by compressibility effects must not be less than **0.07M** unless a lower margin is determined using a rational analysis that includes the **effects of any automatic systems**. In any case, the margin may not be reduced to less than **0.05M**."

"§25.629(e) Flight flutter testing. Full scale flight flutter tests at speeds up to $\mathbf{V_{DF}/M_{DF}}$ must be conducted for new type designs and for modifications to a type design unless the modifications have been shown to have an insignificant effect on the aeroelastic stability. These tests must demonstrate that the airplane has a proper margin of damping at all speeds up to $\mathbf{V_{DF}/M_{DF}}$, and that there is no large and rapid reduction in damping as $\mathbf{V_{DF}/M_{DF}}$ is approached. (…)"

"§25.1505 (…) The speed margin between V_{MO}/M_{MO} and $\mathbf{V_D/M_D}$ **or** $\mathbf{V_{DF}/M_{DF}}$ may not be less than that determined under Sec. 25.335(b) or **found necessary** during the flight tests conducted under Sec. 25.253."

"AC 25-7C Section 32a.(6): Section 25.1505 states that the speed margin between V_{MO}/M_{MO}, and $\mathbf{V_D/M_D}$ **or** $\mathbf{V_{DF}/M_{DF}}$, as applicable, "may not be less than that determined under § 25.335(b) or found necessary during the flight tests conducted under §25.253." Note that **one speed margin** must be established that complies with both §25.335(b) and §25.253. Therefore, if the applicant chooses a V_{DF}/M_{DF} that is less than V_D/M_D, then $\mathbf{V_{MO}/M_{MO}}$ must be **reduced** by the same amount (…)"

Attachment 31B: Proposed changes to 25.335(b) Regulation

The Flight Test Harmonization Working Group recommends the FAA to implement the changes below (marked in blue) to the regulation §25.335(b).

(b) *Design dive speed, V_D*. V_D must be selected so that V_C/M_C is not greater than 0.8 V_D/M_D, or so that the minimum speed margin between V_C/M_C and V_D/M_D is the greater of the values determined from (1) and (2). If the selected V_D includes the effects of non-overridable High-Speed Protection Functions (HSPF), any failure of the system that would affect the design dive speed determination must be shown to be improbable (remote). Any failure of a non-overridable HSPF must be annunciated to the crew such that any speed reduction necessary to meet the conditions of §25.1505(b) is addressed.

(1) Recovery from Airplane Upset: The speed increase occurring during the following maneuvers may be calculated if the resulting speed margin is shown to be reliable or conservative.

(i) Where a HSPF is overridable or not installed, from an initial condition of stabilized flight at V_C/M_C, the airplane is upset, flown for 20 seconds above V_C/M_C along a flight path 7.5° below the initial path, and then pulled up at a load factor of 1.5*g* (0.5*g* acceleration increment). ~~The speed increase occurring in this maneuver may be calculated if reliable or conservative aerodynamic data is used.~~ Power as specified in §25.175(b)(1)(iv) is assumed until the pullup is initiated, at which time power reduction and the use of pilot controlled drag devices may be assumed;

(ii) Where a non-overridable HSPF is installed and operating normally, the speed increase is determined from the greater of (A) and (B) below. If any non-overridable automatic feature is included with the HSPF (e.g. automatic power reduction or automatic application of drag devices), normal operation of these features may be assumed in the maneuvers of (A) and (B).

(A) From an initial condition of stabilized flight at V_C/M_C, the airplane is upset so as to take up a new flight path 7.5 degrees below the initial path. Pilot pitch control application, up to full authority, is made to try to achieve and maintain this new flight path. Twenty seconds after achieving the new flight path at or above V_C/M_C or twenty seconds after reaching full control input at or above V_C/M_C, whichever occurs first, manual recovery is made at a load factor of 1.5 g (0.5g acceleration increment), or such greater load factor that is automatically applied by the system with the pilot's pitch control neutral. Initial power setting, as specified in § 25.175(b)(1)(iv), is assumed. Pilot reduction of power and/or use of drag devices must be delayed until recovery is initiated.

(B) From any likely level cruise speed up to V_C/M_C, with the longitudinal trim and power set to maintain stabilized level flight at this speed, the airplane is upset so as to accelerate through V_C/M_C at a flight path 15 degrees below the initial path (or at the steepest nose down attitude that the system will permit with full pitch control input if less than 15 degrees). The pilot's controls may be in the neutral position after reaching V_C/M_C and before recovery is initiated. Recovery may be initiated three seconds after operation of the high speed warning device or immediately upon reaching V_C/M_C (whichever is higher) by application of a load factor of 1.5 g (0.5g acceleration increment), or such greater load factor that is automatically applied by the system with the pilot's pitch control neutral; power may be reduced simultaneously if not already automatically reduced by the High-Speed Protection Function. All other means of decelerating the airplane, the use of which are authorized up to the highest speed reached in the maneuver, may be used. The interval between successive pilot actions must not be less than one second.

(2) The minimum speed margin must be enough to provide for atmospheric variations (such as horizontal gusts, and penetration of jet streams and cold fronts) and for instrument errors and airframe production variations. These factors may be considered on a probability basis. The margin at altitude where M_C is limited by compressibility effects must not be less than 0.07M unless a lower margin is determined using a rational analysis that includes the effects of any automatic systems. In any case, the margin may not be reduced to less than 0.05M.

Attachment 31C: Proposed changes to 25.335(b) Guidance

The Flight Test Harmonization Working Group recommends the FAA to implement the changes below (marked in blue) to AC 25.335-1A.

1. PURPOSE. This advisory circular (AC) sets forth an acceptable means, but not the only means, of demonstrating compliance with the airworthiness standards for transport category airplanes related to the minimum speed margin between design cruise speed and design dive speed. Like all AC's, it is not regulatory but provides guidance for applicants in demonstrating compliance with the objective safety standards set forth in the rule.

2. CANCELATION. Advisory Circular 25.335-1A, Design Dive Speed, dated 9/29/00, is canceled.

3. RELATED 14 CFR SECTIONS. Part 25, Section 25.335 "Design airspeeds."

4. BACKGROUND. Section 25.335(b) requires the design dive speed, V_D, of the airplane to be established so that the design cruise speed, V_C, is no greater than 0.8 times the design dive speed, or that it be based on ~~an~~ the greater of values resulting from upset criteria as specified in § 25.335(b)(1) and values resulting from atmospheric variations as specified in §25.335(b)(2)~~ initiated at the design cruise speed, V_C~~. At altitudes where the cruise speed is limited by compressibility effects, § 25.335(b)(2) requires the margin to be not less than 0.05 Mach. Furthermore, at any altitude, the margin must be great enough to provide for atmospheric variations (such as horizontal gusts and the penetration of jet streams), instrument errors, and production variations. This AC provides a rational method for considering the atmospheric variations, and also provides guidance on high speed protection functions, air data errors, and upset methods.

5. DESIGN DIVE SPEED MARGIN DUE TO ATMOSPHERIC VARIATIONS.

a. In the absence of substantial evidence supporting alternative criteria, compliance with § 25.335(b)(2) may be shown for all airplanes, including airplanes equipped with High Speed Protection Functions, by providing a margin between V_C/M_C and V_D/M_D sufficient to provide for the following atmospheric conditions.

(...)

b. At altitudes where speed is limited by Mach number, a speed margin of 0.07 Mach between M_C and M_D is considered sufficient without further investigation.

6. HIGH SPEED PROTECTION FUNCTION

High Speed Protection Functions may be used in determining the speed margin between V_C and V_D due to upsets and atmospheric variations. The term "High Speed Protection Function" is defined in the guidance for §25.144. The definition of the probabilistic term "improbable" ("remote") used in this regulation is the same as specified in the guidance for § 25.1309. Failure of HSPF is considered under §25.1505(b) to establish HSPF failed or inoperative operating speed limits.

7. EFFECTS OF AIR DATA ERRORS

If the airspeed indicating system installation error (ref. §25.1323(c)) is shown to be within a 3 KEAS tolerance at V_C/M_C, then the upsets of §25.335(b)(1) need not be combined with instrument errors.

If the airspeed indicating system installation error (ref. §25.1323(c)) is shown to be within a 3 KEAS tolerance at V_C/M_C and the atmospheric conditions presented in section 5.a. of this AC are used in the assessment of atmospheric variations of §25.335(b)(2), then additional considerations for air data instrument errors at V_C/M_C need not be considered for §25.335(b)(2).

If the airspeed indicating system installation error (ref. §25.1323(c)) is not shown to be within a 3 KEAS tolerance at V_C/M_C, then the margin to V_D/M_D due to upsets of §25.335(b)(1) and atmospheric variations of §25.335(b)(2) should account for that entire error. In any case, errors in the conservative sense need not be considered.

If the aircraft response is dependent on air data input to any automatic system (e.g. HSPF gain schedules, Nz command, control law gains, feedback or feedforward factors, etc. are a function of the input air data in the overspeed range) then the applicant should consider the effects of air data errors (i.e. errors in the air data input for the HSPF) in the overspeed range in order to ensure that the resulting analytically calculated speed margins from §25.335(b)(1) and (b)(2) are reliable or conservative.

Where compliance with §25.335(b)(1) or (b)(2) is dependent upon activation of an overspeed warning, the system tolerances should be considered. For an airplane with digital interface between the airspeed system and the overspeed warning system, the production tolerance for the overspeed warning system may be deleted when adequately substantiated; therefore only the nominal setting of the overspeed warning activation should be considered.

8. UPSET METHODS

Paragraph 25.335(b)(1) requires the airplane to be upset. It is acceptable to perform these upsets by only pushing the aircraft nose down. The applicant may propose other methods to upset the airplane such as a pitch up followed by a pitch down, but it is not mandatory. Thus, for §25.335(b)(1)(ii)(A) it is not necessary to decelerate the airplane after trimming at V_C/M_C even if the flight path 7.5 degrees below the initial path is not obtained. For §25.335(b)(1)(ii)(B), the applicant may select the maximum trimmed speed that will allow the airplane to accelerate through V_C/M_C at a flight path 15 degrees below the initial path (or at the steepest nose down attitude that the system will permit with full pitch control input if less than 15 degrees). The effect of the initial trimming condition on the resulting speed margin after the upsets depend on certain aircraft characteristics. For example, with airplanes having neutral speed stability (e.g. auto-trim), the starting point trimming condition might be irrelevant.

Attachment 31D: Proposed changes to 25.629(e) Guidance

The Flight Test Harmonization Working Group recommends the FAA to implement the changes below (marked in blue) to AC 25.629-1B, Section 7.2.5 – Flight Flutter Tests.

7.2.5 Flight Flutter Tests.

7.2.5.1 Full-scale flight flutter testing of an airplane configuration to V_{DF}/M_{DF} is a necessary part of the flutter substantiation. An exception may be made when aerodynamic, mass, or stiffness changes to a certified airplane are minor, and analysis or ground tests show a negligible effect on flutter or vibration characteristics. If a failure, malfunction, or adverse condition is simulated during a flight test, the maximum speed investigated need not exceed V_{FC}/M_{FC} if it is shown, by correlation of the flight test data with other test data or analyses, that the requirements of § 25.629(b)(2) are met.

7.2.5.2 Airplane configurations and control system configurations should be selected for flight test based on analyses and, when available, model test results. For airplanes equipped with a High Speed Protection Function, the envelope protections may be disabled or modified (e.g. Direct Mode; Alternate Mode, flight test dedicated control law) to allow reaching the selected values of V_{DF}/M_{DF} during flutter flight tests. If the flutter characteristics of the airplane with the envelope protections disabled or modified are substantially different than the expected normal mode flutter characteristics, then additional substantiation should be presented addressing those differences. Sufficient test conditions should be performed to demonstrate aeroelastic stability throughout the entire flight envelope for the selected configurations.

(…)

Attachment 31E: Proposed changes to 25.1505 Regulation

The Flight Test Harmonization Working Group recommends the FAA to implement the changes below (marked in blue) to the regulation §25.1505.

§25.1505 Maximum operating limit speed.

The maximum operating limit speed (V_{MO}/M_{MO} airspeed or Mach ~~N~~ number, whichever is critical at a particular altitude) is a speed that may not be deliberately exceeded in any regime of flight (climb, cruise, or descent), unless a higher speed is authorized for flight test or pilot training operations.

(a) V_{MO}/ M_{MO} must be established so that it is not greater than the design cruising speed V_C/M_C and so that it satisfies the speed margins defined in § 25.253(d). ~~is sufficiently below V_D/M_D or V_{DF}/M_{DF}, to make it highly improbable that the latter speeds will be inadvertently exceeded in operations. The speed margin between V_{MO}/M_{MO} and V_D/M_D or V_{DF}/M_{DF} may not be less than that determined under § 25.335(b) or found necessary during the flight tests conducted under § 25.253.~~

(b) For airplanes utilizing a High Speed Protection Function (HSPF), operating speed limits must be established for failures of the system accounting for appropriate margins to V_{DF}/M_{DF}, unless the failure is shown to be extremely improbable and not caused by any single failures.

Attachment 31F: Proposed changes to 25. 253 and 25.1505 Guidance

The Flight Test Harmonization Working Group recommends the FAA implement the changes below (marked in blue) to AC 25-7D section 10.2 to support the proposed new subparagraph 25.253(d) and proposed changes to 25.1505, and to AC 25-7D Chapter 39 to support the proposed new subparagraph 25.1505(b).

AC 25-7D § 10.2 High Speed Characteristics—§ 25.253.

10.2.1 Explanation.

10.2.1.1 The maximum flight demonstrated dive speed, V_{DF}/M_{DF}, selected by the applicant, is used ~~along with V_D/M_D~~ when establishing V_{MO}/M_{MO} in accordance with the associated speed margins under the provisions of §25.253(d) and §25.1505(a). Both V_{MO}/M_{MO} and V_{DF}/M_{DF} are then evaluated during flight tests for showing compliance with §25.253(a). The operational upsets expected to occur in service for pitch, roll, yaw, and combined axis upsets are evaluated when showing compliance to §25.253(a)(1) and should not result in exceeding V_{DF}/M_{DF}.

~~10.2.1.2 The pitch upset defined in § 25.335(b), as amended by amendment 25-23, or defined in § 25.1505, prior to amendment 25-23, provides a means for determining the required speed margin between V_{MO}/M_{MO} and both V_D/M_D and V_{DF}/M_{DF}. The operational upsets expected to occur in service for pitch, roll, yaw, and combined axis upsets are evaluated when showing compliance to § 25.253 and must not result in exceeding V_D/M_D or V_{DF}/M_{DF}.~~

10.2.1.2 Although typically V_{DF}/M_{DF} is selected to be equal to V_D/M_D, an applicant may select and demonstrate V_{DF}/M_{DF} as a speed less than V_D/M_D. For instance, V_{DF}/M_{DF} may be reduced to a speed necessary to meet flight characteristics requirements or V_D/M_D could be selected conservatively high as a structural design option. In any case, per §25.253(d), the minimum margin applicable to V_C/M_C and V_D/M_D resulting from §25.335(b)(1) and (2), with the design airspeeds V_C and V_D expressed in CAS, is also applicable to the margin between V_{MO}/M_{MO} and V_{DF}/M_{DF}. Therefore, if the applicant chooses a V_{DF}/M_{DF} that is less than V_D/M_D, then V_{MO}/M_{MO} may need to be reduced to maintain the required speed margin to V_{DF}/M_{DF}.

10.2.1.5 At least the following factors should be considered in determining the necessary flight tests:

(…)

10.2.1.5.9 Effective and unmistakable aural speed warning at V_{MO} plus 6 knots, or M_{MO} plus 0.01 M (ref. 25.1303(c)(1)), or per considerations in 10.2.1.6.6.

10.2.1.6 ~~Section 25.1505 states that the speed margin between V_{MO}/M_{MO}, and V_D/M_D or V_{DF}/M_{DF}, as applicable, "may not be less than that determined under § 25.335(b) or found necessary during the flight tests conducted under § 25.253." Note that one speed margin must be established that complies with both § 25.335(b) and § 25.253. Therefore, if the applicant chooses a V_{DF}/M_{DF} that is less than V_D/M_D, then V_{MO}/M_{MO} must be reduced by the same amount (i.e., compared to what it could be if V_{DF}/M_{DF} were equal to V_D/M_D) in order to provide the required speed margin to V_{DF}/M_{DF}.~~ In ~~determining~~ showing that the speed margin between V_{MO}/M_{MO} and V_{DF}/M_{DF} is sufficient ~~during type certification programs~~, the factors outlined in paragraph 10.2.1.5 above should also be considered in addition to the items listed below:

10.2.1.6.1 Increment for production tolerances in airspeed systems (0.005 M), unless larger ~~differences~~ tolerances are found to exist. Smaller tolerances may also be accepted if adequately substantiated.

10.2.1.6.2 Increment for ~~production tolerances of~~ overspeed warning ~~error~~ margin and system tolerances (0.0l M per 25.1303(c)(1) and considerations in 10.2.1.6.6).

10.2.1.6.3 The increment (ΔM) due to speed overshoot from M_{MO}, established during flight tests in accordance with § 25.253(a)(1), should be added to the values for airspeed system production ~~differences~~ tolerances and

~~equipment~~ overspeed warning margin and system tolerances. The value of M_{MO} ~~may not be greater than the lowest value obtained from each of each of the following equations~~ must meet the following criteria, which reflect the requirements of §§ 25.253(a)(1), 25.253(d) and 25.1505(a):

$$M_{MO} \leq M_C$$

And

$$M_{MO} \leq M_{DF} - \Delta M - 0.005M - 0.01M$$

~~Or~~ And

$$M_{MO} \leq M_{DF} - \cancel{0.01}(M_D - M_C)_{MIN}$$

~~Note: The combined minimum increment may be reduced from 0.07 M to as small as 0.05 M if justified by the rational analysis used to show compliance with § 25.335(b)(2).~~

Where:

0.005M=Airspeed system production tolerances (ref. 10.2.1.6.1)

0.01M= Overspeed warning margin and system tolerances (ref. 10.2.1.6.2)

ΔM = Mach increase due to overshoot from M_{MO} established during flight tests in accordance with §25.253(a)(1)

$(M_D-M_C)_{MIN}$ = The minimum margin between M_C and M_D applicable to the selection of M_D determined under §25.335(b)

10.2.1.6.4 At altitudes where V_{MO} is limiting, the increment for ~~production differences of airspeed systems and~~ production tolerances in airspeed systems is 3 knots ~~of overspeed warning errors are 3 and 6 knots, respectively~~, unless larger ~~differences or errors~~ tolerances are found to exist. Smaller airspeed tolerances may also be accepted if adequately substantiated. The increment for overspeed warning margin and system tolerances is 6 knots (ref. 25.1303(c)(1)), or per considerations in 10.2.1.6.6.

10.2.1.6.5 The increment (ΔV) due to speed overshoot from V_{MO}, established during flight tests in accordance with § 25.253(a)(1), should be added to the values for airspeed system production ~~differences~~ tolerances and ~~equipment~~ overspeed warning margin and system tolerances. The value of V_{MO} ~~should not be greater than the lowest obtained from the following equation, and from § 25.1505~~ must meet the following criteria, which reflect the requirements of §§ 25.253(a)(1), 25.253(d) and 25.1505(a):

$$V_{MO} \leq V_C$$

And

$$V_{MO} \leq V_{DF} - \Delta V - 3\ knots\ CAS - 6\ knots\ CAS$$

And

$$V_{MO} \leq V_{DF} - \cancel{0.01}(V_D - V_C)_{MIN}$$

Where:

3 knots CAS =Airspeed system production tolerances

6 knots CAS=~~Equipment~~ Overspeed warning margin and system tolerances

ΔV = Speed increase due to overshoot from V_{MO}, established during flight tests in accordance with §25.253(a)(1)

$(V_D-V_C)_{MIN}$ = The minimum margin between V_C and V_D (expressed in CAS) applicable to the selection of V_D determined under §25.335(b)

10.2.1.6.6 For an airplane with digital interface between the airspeed system and the overspeed warning system, the ~~production tolerance for the~~ overspeed warning system tolerance may be deleted when adequately substantiated, leaving only the nominal margin between V_{MO}/M_{MO} and the overspeed warning activation to be included.

10.2.1.6.7 An applicant may propose to execute the §25.335(b)(1) upsets in flight to complement compliance to 25.253(a)(1). In this case, industry practice suggests that the conservative nature of these upsets is such that the airspeed system production tolerances and overspeed warning system tolerances described in 10.2.1.6.3 and 10.2.1.6.5 need not be accounted for.

CHAPTER 39. OPERATING LIMITATIONS AND INFORMATION: OPERATING LIMITATIONS ~~[RESERVED]~~

Guidance for §25.1505(b):

The minimum margin between the operating speed limits for High Speed Protection Function (HSPF) failed/inoperative and V_{DF}/M_{DF} should be established through rational analyses according to the requirements set forth in either:

1. §25.335(b)(1)(i) and (b)(2), if the airplane in the failed state is capable of maintaining a 7.5 degree nose down attitude with power as per §25.175(b)(1)(iv) for 20 seconds starting at the operating speed limits for the failure of the HSPF, or,

2. §25.335(b)(1)(ii) and (b)(2), if the airplane in the failed state is incapable of maintaining a 7.5 degree nose down attitude using up to full pilot pitch control input with power as per §25.175(b)(1)(iv) for 20 seconds starting at the operating speed limits for the failure of the HSPF.

Dispatch of the airplane with the HSPF inoperative may be acceptable under an approved MMEL, provided that flight manual instructions indicate appropriate operating speed limits, as described in paragraph §25.1505(b). In addition, the cockpit display of the HSPF failed/inoperative operating speed limits, as well as the overspeed warning for exceeding those speeds, must be equivalent to that of the normal airplane with the HSPF operative. These requirements address the potential hazard of increased dive speeds with the HSPF inoperative. No additional hazards may be introduced with the HSPF inoperative.

Attachment 31G: Proposed changes to Subpart B Regulations

The Flight Test Harmonization Working Group recommends the FAA to implement the changes below (marked in blue) to Subpart B regulations §25.253 and §25.255.

Notes:

i. Text marked in red was already proposed as part of the FTHWG Phase 2 report (Topic 13).

ii. No changes are proposed for §25.251(b) or §25.253(a)(5). Paragraphs included for reference only.

25.251(b):

Each part of the airplane must be demonstrated in flight to be free from excessive vibration under any appropriate speed and power conditions up to V_{DF}/M_{DF}. The maximum speeds shown must be used in establishing the operating limitations of the airplane in accordance with §25.1505.

25.253(a)(3):

With the airplane trimmed at any speed up to V_{MO}/M_{MO}, there must be no reversal of the response to control input about any axis at any speed up to V_{DF}/M_{DF}. Any tendency to pitch, roll, or yaw must be mild and readily controllable, using normal piloting techniques. When the airplane is trimmed at V_{MO}/M_{MO}, the slope of the elevator control force versus speed curve need not be stable at speeds greater than V_{FC}/M_{FC}, but there must be a push force at all achievable speeds (under normal flight control system operation) up to V_{DF}/M_{DF}, and there must be no sudden or excessive reduction of ~~elevator~~ pitch control force as V_{DF}/M_{DF} is reached.

25.253(a)(4):

Adequate roll capability to assure a prompt recovery from a lateral upset condition must be available at any speed up to V_{DF}/M_{DF}. The demonstrations need not be initiated at a speed so high that V_{DF}/M_{DF} would be exceeded during the maneuver.

25.253(a)(5):

With the airplane trimmed at V_{MO}/M_{MO}, extension of the speedbrakes over the available range of movements of the pilot's control, at all speeds above V_{MO}/M_{MO}, but not so high that V_{DF}/M_{DF} would be exceeded during the maneuver, must not result in:

(i) An excessive positive load factor when the pilot does not take action to counteract the effects of extension;

(ii) Buffeting that would impair the pilot's ability to read the instruments or control the airplane for recovery; or

(iii) A nose down pitching moment, unless it is small.

25.253(b):

Maximum speed for stability characteristics. V_{FC}/M_{FC}. V_{FC}/M_{FC} is the maximum speed at which the requirements of §§ 25.143(g), 25.147(e), 25.175(b)(1), 25.177, and 25.181 must be met with flaps and landing gear retracted. Except as noted in § 25.253(c), V_{FC}/M_{FC} may not be less than a speed midway between V_{MO}/M_{MO} and V_{DF}/M_{DF}, except that for altitudes where Mach number is the limiting factor, M_{FC} need not exceed the Mach number at which effective speed warning occurs. For airplanes equipped with a non-overridable High Speed Protection Function, V_{FC}/M_{FC} also need not exceed the maximum speed achievable with full forward pitch control input, unless that speed would be less than the speed at which effective speed warning occurs (per § 25.1303(c)(1)).

25.253(d):

Demonstrated flight diving speed, V_{DF}/M_{DF}. The demonstrated flight diving speed, V_{DF}/M_{DF}, is a speed selected by the applicant as not greater than V_D/M_D and such that the speed margin between V_{MO}/M_{MO} and V_{DF}/M_{DF} is not lower than the larger of:

(i) The minimum speed margin between V_C/M_C and V_D/M_D, applicable to the selection of V_D/M_D determined under §25.335(b)(1) and (b)(2); and

(ii) That found necessary during the flight tests conducted under §25.253(a)(1).

25.255(b):
In the out-of-trim condition specified in paragraph (a) of this section, when the normal acceleration is varied from +1 g to the positive and negative values specified in paragraph (c) of this section—
(1) The stick force vs. g curve must have a positive slope at any speed up to and including V_{FC}/M_{FC}; and
(2) At speeds between V_{FC}/M_{FC} and any achievable speed (under normal flight control system operation) up to V_{DF}/M_{DF} the direction of the primary longitudinal control force may not reverse.

25.255(f):
In the out-of-trim condition specified in paragraph (a) of this section, it must be possible ~~from an~~ at any achievable overspeed condition (under normal flight control system operation) up to V_{DF}/M_{DF}, to produce at least 1.5 g for recovery by applying not more than 125 pounds of longitudinal control force for a control wheel or 50 pounds for a side stick, using either the primary longitudinal control system alone or the primary longitudinal control and the longitudinal trim system. If the required 1.5 g load factor is shown at a maximum achievable speed less than V_{DF}/M_{DF} or if the longitudinal trim system is used to assist in producing the required load factor, it must be possible to promptly produce at least 1.2 g at V_{DF}/M_{DF} by applying not more than 125 pounds of longitudinal control force for a control wheel or 50 pounds for a side stick, using the primary longitudinal control alone. If the longitudinal trim system is used to assist in producing the required 1.5 g load factor, it must also be shown ~~at V_{DF}/M_{DF},~~ that the longitudinal trim surface can be actuated in the airplane nose-up direction at V_{DF}/M_{DF} with the primary surface loaded to correspond to the least of the following airplane nose-up control forces:

(…)

Attachment 31H: Proposed changes to Subpart B Guidance

The Flight Test Harmonization Working Group recommends the FAA to implement the changes below (marked in blue) to AC 25-7D.

Notes:

i. Text marked in red was already proposed as part of the FTHWG Phase 2 report (Topic 1, 7 and 13).

ii. Attachment 31F contains additional proposed changes to Subpart B guidance, specific to §25.253.

~~AC 25-7C (31.a.(8)~~ [Delete this section previously proposed in Topic 1]
~~(8) If a high speed protection function (HSPF) is installed and that function prevents the aircraft from readily achieving the selected V_{DF}/M_{DF}, the HSPF may be adjusted or disabled to permit demonstrations showing compliance to § 25.251(b) provided the aerodynamic configuration of the airplane during the demonstration is the same as would be present if the HSPF were functioning normally.~~

AC 25-7D § 10.1.2.2 – Section 25.251(b):
The airplane should be flown at V_{DF}/M_{DF} at several altitudes from the highest practicable cruise altitude to the lowest practicable altitude. For this demonstration, flight envelope protections may be disabled or modified (e.g. Direct Mode; Alternate Mode; flight test dedicated control law) to allow reaching V_{DF}/M_{DF}. The test should be flown starting from trimmed flight at V_{MO}/M_{MO} at a power or thrust setting not exceeding maximum continuous power or thrust. The airplane gross weight should be as high as practicable for the cruise condition, with the CG at or near the forward limit. In addition, compliance with § 25.251(b) should be demonstrated with high drag devices (i.e., speed brakes) deployed at V_{DF}/M_{DF}. Thrust reversers, if designed for inflight deployment, should be deployed at their limit speed conditions. ~~A high-speed protection function, if installed, may be adjusted or disabled as discussed in paragraph 31.a.(8) if necessary to permit demonstrations at V_{DF}/M_{DF}.~~

AC 25-7D (Propose new section in 10.2.1)
§ 10.2.1.7: Considerations for Aircraft Employing a High Speed Protection Function
10.2.1.7.1
Some aircraft may utilize a High Speed Protection Function (HSPF) which acts to reduce speed excursions beyond the normal operating envelope. An HSPF is likely to become active during maneuvers described in paragraph 10.2.3 ~~32.c~~. If an HSPF of suitable availability is installed, the upset maneuvers specified in paragraphs 10.2.3.1 through 10.2.3.5 ~~32.c.(1) through (5)~~ below can be limited to that which is achievable with the HSPF functioning normally and the pilot's pitch control full forward, and a load factor in excess of 1.5 g may be used during recovery if applied automatically by the HSPF with the pilots pitch control at the neutral (zero force) position. For the purposes of compliance with § 25.253, suitable availability of an HSPF means that the probability of loss of the function should be improbable/remote (on the order of 10^{-5} per flight hour or less).

Adequate handling qualities (e.g. adequate roll rate, normal load factor capability, control force gradients and absence of control reversal) should be observed during the recovery demonstrations from the upset maneuvers of §25.253(a)(1). In addition, compliance with paragraphs 25.253(a),(3),(4),(5), (b) and 25.255(b), (f) include demonstrations in Normal Mode at a reasonably stable airspeed/Mach number, defined as the maximum speed achieved following a gradual wings-level acceleration (for example, on the order of 1kt/s acceleration) to full forward pitch control input.

§ 10.2.1.7.2
An HSPF when functioning normally may, by design, limit the airspeed the airplane can achieve even with full forward pitch control; however, an applicant may ~~choose to demonstrate high-speed flight characteristics at a~~ selected V_{DF}/M_{DF} speeds higher than can be achieved with full forward pitch control. ~~This might be done in order to meet requirements for margin from V_{MO}/M_{MO} to V_{DF}/M_{DF}.~~ If an HSPF is installed and an applicant chooses to demonstrate high speed characteristics at a selected V_{DF}/M_{DF} that cannot readily be achieved with the nominal HSPF settings, ~~the HSPF may be adjusted or disabled~~ the

applicant can use any means to permit achievement of that higher speed for demonstrations of control characteristics and speedbrake extension at V_{DF}/M_{DF} showing compliance to § 25.253(a)(3) – (5), provided the aerodynamic configuration and the airplane capability in pitch and roll during the demonstration at V_{DF}/M_{DF} ~~should be the same~~ can be used to correlate with the normal mode expected behavior ~~as would be present if the HSPF were functioning normally~~. In this way the underlying aerodynamic control capability and buffet characteristics are demonstrated to V_{DF}/M_{DF}. Demonstrations showing compliance to § 25.253(a)(1) and (2) (handling qualities, speed excursion and load factor control and buffeting during recovery from specified maneuvers) should be performed with the HSPF functioning normally.

AC 25-7D: (Propose new section in 10.2.3)

10.2.3.X General Flight Characteristics, 25.253(a)(3)

§25.253(b) establishes that maneuvering characteristics of §25.143(g), lateral control characteristics of §25.147(e) and the stability characteristics of §§25.175(b)(1), 25.177 and 25.181 must be met at speeds up to V_{FC}/M_{FC}.

Beyond V_{FC}/M_{FC}, §25.253(a)(3) requires the airplane be shown to respond in the conventional sense to control inputs in each axis at any speed up to V_{DF}/M_{DF}. For airplanes equipped with a non-overridable High Speed Protection function, this may be evaluated with the envelope protections disabled or modified (e.g. Direct Mode; Alternate Mode; flight test dedicated control law) to allow reaching V_{DF}/M_{DF}. During this testing, it should also be confirmed that no sudden or excessive reduction of longitudinal control force occurs as V_{DF}/M_{DF} is reached.

In addition, it must be shown that a push force is required to achieve speeds up to V_{DF}/M_{DF}, or the maximum speed that is achievable with a High Speed Protection System operating normally, whichever is lower.

AC 25-7D § 10.2.3.6 – Roll Capability – Section 25.253(a)(4)

§ 10.2.3.6.2 Test Procedure.

An acceptable method of demonstrating that roll capability is adequate to assure prompt recovery from a lateral upset condition is as follows:

1. Establish a steady 20-degree banked turn at the maximum achievable speed (under normal flight control system operation) up to V_{DF}/M_{DF} ~~a speed close to~~ ~~V_{DF}/M_{DF}~~, limited to the extent necessary to accomplish the following maneuver and recovery without exceeding V_{DF}/M_{DF}. Using lateral control alone, it should be demonstrated that the airplane can be rolled to a 20° bank angle in the opposite direction in not more than 8 seconds. The demonstration should be made in the most adverse direction. The maneuver may be unchecked.
2. For airplanes equipped with a non-overridable High Speed Protection function, adequate roll capability for prompt recovery from a lateral upset should also be shown at the maximum speed achieved during recovery from the lateral and two-axis upsets as described in Section 10.2.3.3.1 and 10.2.3.3.3 of this AC. In addition, roll capability must be shown to be adequate up to V_{DF}/M_{DF} with the envelope protections disabled or modified (e.g. Direct Mode; Alternate Mode; flight test dedicated control law) if so required to allow reaching V_{DF}/M_{DF}. The demonstrations need not be initiated at a speed so high that V_{DF}/M_{DF} would be exceeded during the maneuver.
3. For airplanes that exhibit an adverse effect on roll rate when rudder is used, it should also be demonstrated that use of rudder to pick up the low wing in combination with the lateral control will not result in a roll capability significantly below that specified above.

AC 25-7D § 10.2.3.7 – Extension of Speedbrakes

§10.2.3.7.3

The effect of extension of speedbrakes may be evaluated during other high speed testing (for example, paragraph 10.1.2.2 and paragraphs 10.2.3.1 through 10.2.3.5 of this AC) and during the development of emergency descent procedures. It may be possible to infer compliance with § 25.253(a)(5) by means of this testing. To aid in determining compliance with the qualitative requirements of this rule, the following quantitative values may be used as a generally acceptable means of compliance. A positive load factor should be regarded as excessive if it exceeds 2 g. A nose-down pitching moment may be regarded as small if it necessitates an incremental force of less than 20 pounds ~~lbs~~ for a conventional control wheel or 15 pounds for a side stick controller to maintain 1 g flight. These values may not be appropriate for all airplanes, and will depend on the characteristics of the particular airplane design in high speed flight. Other means of compliance may be acceptable, provided that compliance has been shown to the qualitative requirements specified in § 25.253(a)(5). For airplanes equipped with a High Speed Protection function, for which the selected values of V_{DF}/M_{DF} might not be achievable in flight test in a configuration representative of the normal operation of the flight controls system, the use of analysis and/or simulation may be acceptable to show compliance between the maximum speed demonstrated in flight and V_{DF}/M_{DF}.

AC 25-7D § 10.3 - Out-of-Trim Characteristics – Section 25.255.

§10.3.1 Explanation

(…)

With the advent of Electronic Flight Control Systems ("Fly-By-Wire"), some airplanes have included automatic longitudinal trim systems whereby the trim surface position is automatically adjusted without direct command from the pilot. Such systems have the ability to minimize or eliminate the potential mistrim of the trimming surface under normal operation. However, depending on the design of the automatic trim system, some level of mistrim may exist at high speed cruise conditions under normal maneuvering conditions or atmospheric disturbances, including those leading to the "jet upsets" described above. It is the intent of this regulation to demonstrate the required maneuvering characteristics in any achievable high speed condition up to V_{DF}/M_{DF} and minimum controllability at V_{DF}/M_{DF} with the level of mistrim that can be expected in service, including any automatic movement, in response to normal maneuvering and atmospheric disturbances expected in the cruise phase of flight.

The maximum achievable speed for maneuvering characteristics demonstration, referred to in sec. 25.255(b)(2), is a reasonably stable airspeed/Mach number, defined as the maximum speed achieved following a gradual wings-level acceleration (for example, on the order of 1kt/s acceleration) to full forward pitch control input ~~the maximum speed reached during maneuvers specified for compliance with 25.253(a)(1) in paragraph 32.c. of this AC, conducted with the flight control system and envelope protections operating normally. This speed may be lower than or equal to V_{DF}/M_{DF} at some or all altitudes in the envelope to be approved depending on the criteria used to establish V_{DF}/M_{DF}~~.

§10.3.2.2

Section 25.255(b) establishes the basic requirement to show positive maneuvering stability throughout a specified normal acceleration envelope at all speeds to V_{FC}/M_{FC}, and the absence of longitudinal control force reversals throughout that normal acceleration envelope at speeds between V_{FC}/M_{FC} and any achievable speed up to V_{DF}/M_{DF} with the flight control system (including envelope protections) operating normally. (Later subsections (d) and (e) recognize that buffet boundary, envelope protections or other limiting features, and control force limits will limit the normal acceleration actually reached; this does not account for Mach trim gain, etc.)

§10.3.2.7

Section 25.255(f) requires that, in the out-of-trim condition specified in § 25.255(a), it must be possible to produce at least 1.5g during recovery from any achievable ~~the~~ overspeed condition (under normal flight control system operation) up to ~~of~~ V_{DF}/M_{DF}, or at the maximum achievable speed with the flight control system (including envelope protections) operating normally, by applying not more than 125 pounds of longitudinal control force for a conventional control wheel or 50 pounds for a side stick controller. If adverse flight characteristics preclude the attainment of this load factor at the highest altitude reasonably expected for recovery to be initiated at ~~V_{DF}/M_{DF}~~ the overspeed condition following an upset at high altitude, the flight envelope (e.g., V_{DF}/M_{DF}, altitude, etc.) of the airplane should be restricted to a value where 1.5 g is attainable. Inability to attain 1.5 g due to encountering deterrent buffet or envelope protection is not considered an adverse flight characteristic.

For airplanes equipped with a High Speed Protection Function (HSPF) that acts to reduce speed excursions beyond the normal operating envelope, §25.255(f) allows limiting the demonstration of the required 1.5 g recovery capability to the maximum achievable airspeed with the HSPF functioning normally and the pilot's pitch control full forward. For the purposes of compliance with § 25.255(f), it should be shown that the HSPF has suitable availability and that the probability of loss of the function should be improbable/remote (on the order of 10^{-5} per flight hour or less).

If the required 1.5 g load factor is shown at the maximum achievable speed with HSPF functioning normally, it must also be shown that it is possible to produce at least 1.2 g recovery capability at V_{DF}/M_{DF} using the primary longitudinal control (without assistance from the longitudinal trim surface). For this demonstration, flight envelope protections may be disabled or modified (e.g. Direct Mode; Alternate Mode; flight test dedicated control law) to allow reaching V_{DF}/M_{DF}. The objective of this test is to demonstrate that the airplane and its flight control system are capable of producing ~~1.5~~1.2 g during recovery from an overspeed condition, even if a protection system would normally act to deter or prevent such an overspeed encountered due to upsets similar to those used for compliance with Section 25.253(a). This could include more extreme upsets or large horizontal wind shear or gusts that result in momentary exceedences of the normally achievable airspeed with the protections operating normally.

Although a pilot commanded or automatic trim input may be used to assist in producing the required normal ~~acceleration~~ load factor of 1.5 g, it is not acceptable for recovery to be completely dependent upon the ~~pilot~~ commanded trim input. It should be possible to promptly produce at least 1.2 g at V_{DF}/M_{DF} by applying not more than 125 pounds of longitudinal control force for a conventional control wheel or 50 pounds for a side stick using the primary longitudinal control alone. If trim surface movement must be used for the purpose of obtaining 1.5 g, whether commanded by manual pilot trim inputs or by the automatic trim system, it must be shown to operate with the primary control surface loaded to the least of three specified values and it must be possible for the pilot to command the pitch trim while maintaining the appropriate level of pull force.

(...)

§10.3.3 - Procedures

§ 10.3.3.1 Compliance is determined by the characteristics of F_S/g (normally a plot). Any standard flight test procedure that yields an accurate evaluation of F_S/g data in the specified range of speeds and acceleration should be considered for acceptance. Bounds of investigation and acceptability are set forth in the rule and in discussion material above, and broad pilot discretion is allowed in the selection of maneuvers.

§ 10.3.3.1.1

For airplanes that include a design that provides automatic trimming under all cruise flight conditions (including auto-flight), the amount of mistrim should be determined by analysis, accounting for system design, thresholds for automatic trimming, and system tolerances. It must also account for any mistrim that may result from normal maneuvering or atmospheric disturbance expected in cruise flight. If the possible mistrim is considered negligible (and paragraph (a)(1) is not applicable) the testing required by paragraphs (b) through (f) can be conducted with no specific level of mistrim. Alternatively, if the amount of mistrim is not negligible, it would be considered acceptable to conduct the flight testing with no specific mistrim if it can be shown by analysis that, (1) the level of mistrim does not affect the maneuvering characteristics (Fs vs g) of the airplane (e.g., a maneuver demand control system) and (2) the maneuvering capability ~~of 1.5g~~ demonstrated during flight tests for §25.255(f) would still be possible if the mistrim was present at the start of the recovery (this could be shown by demonstrating controllability beyond ~~1.5g~~ that required by §25.255(f) during flight test and adjusting the peak Nz achieved by the effect of the mistrim on pitching moment, or by showing sufficient margin in elevator authority during the flight tested recovery at 1.5g and 1.2g, as applicable, to offset the possible level of mistrim and still generate the required load factor~~1.5g~~).

§ 10.3.3.1.2

The flight testing for § 25.255(b) is required at achievable airspeeds up to V_{DF}/M_{DF} ~~(established in accordance with §25.253(a))~~, with the flight control system (including envelope protections) operating normally. While conducting these tests, the airplane should be accelerated from a level flight condition at V_{MO}/M_{MO} (or any lower initial airspeed with the level of mistrim established with paragraph (a) above) using up to Maximum Continuous Thrust to the target airspeed. Testing should be conducted with the flight control system operating normally to accurately present the airplane's maneuvering characteristics. ~~Upset maneuvers similar to those used to establish the achievable overspeed conditions during certification tests for § 25.253(a) may be necessary to achieve the airspeed for the maneuvering characteristics demonstration.~~ If full forward pitch control input is required to maintain the target airspeed after it is achieved, no pushover maneuver is possible. A wings-level pull-up or constant speed/Mach wind-up turn maneuver to the extent required for the maneuver should be accomplished from this condition with the control system operating normally, including any automatic trim surface movement.

§ 10.3.3.1.3

The flight testing for § 25.255(f) ~~is required~~ to show that the airplane provides the required recovery capability at V_{DF}/M_{DF} may be conducted with the ~~flight control system operating normally, except that~~ flight envelope protections ~~may be~~ disabled or modified (e.g. Direct Mode; Alternate Mode; flight test dedicated control law) if necessary to allow reaching V_{DF}/M_{DF}. While conducting ~~these~~ the tests required by §25.255(f), the airplane should be accelerated from a level flight condition at V_{MO}/M_{MO} (or any lower initial airspeed with the level of mistrim established with paragraph (a) above) using up to Maximum Continuous Thrust until the target airspeed ~~V_{DF}/M_{DF}~~ is achieved or full forward pitch control is reached. A wings-level pull-up maneuver to at least ~~1.5g~~ the required load factor should be accomplished from this condition ~~with the control system operating normally, including any automatic trim surface movement~~.

Recovery capability is generally critical at altitudes where airspeed (V_{DF}) is limiting. If at the highest altitude reasonably expected for recovery to be initiated at V_{DF}/M_{DF} (or the maximum achievable speed for an HSPF equipped airplane) following an upset the maneuver capability is limited by buffeting of such an intensity that it is a strong deterrent to further increase in normal acceleration or an AOA Limit imposed by a High Angle of Attack Limiting Function is reached, some reduction of maneuver capability will be acceptable, provided that it does not reduce to below 1.3 g and that 1.5 g is possible at lower altitudes. The entry speed for flight test demonstrations of compliance with this requirement should be limited to the extent necessary to accomplish a recovery without exceeding V_{DF}/M_{DF}, and the normal acceleration should be measured as near to the target airspeed ~~V_{DF}/M_{DF}~~ as is practical.

§ 10.3.3.1.4

In accordance with § 25.255(e), the maneuvering characteristics tests for § 25.255(b) and any extrapolation of Nz in accordance with § 25.255(c)(2) need only extend to the lesser of

(a) The levels defined in § 25.255(c);

(b) The positive load factors associated with probable inadvertent excursions beyond the boundaries of the buffet onset envelopes determined under § 25.251(e); and

(c) The +/- load factors achievable at the test airspeed with the flight control system operating normally, including high speed protections, AOA limiting, Nz limiting, or other control system limitations.